

**Toxicological Investigations of Mining
Effluents (TIME)**

Workshop Proceedings

**Ottawa, Ontario
November 25-26, 1999**

Table of Contents

1. Background and Context.....	6
2. Purpose and Structure of the Workshop	7
3. Summary of Plenary Presentations	8
3.1 New Metal Mining Effluent Regulations (MMER) and Non-acutely Lethal Effluent (NLE) Requirements—Patrick Finlay (Environment Canada)	8
3.2 General Aspects of Toxicology—Jim McGeer (CANMET, Natural Resources Canada).....	8
3.3 Acute Lethality Reference Methods—Gary Westlake (Ontario Ministry of the Environment).....	9
3.4 Synopsis of the Report Analysis of National Acute Lethality Database on Canadian Mining Effluent—Paul Rochon (Environment Canada)	9
3.5 Overview of Efforts to Address the Mining Effluent Acute Lethality Issue—Rick Scroggins (Environment Canada)	10
3.6 An Overview of Mine Effluent Treatment and Estimated Costs—Mark Anderson (SENES Consultants Ltd.)	10
3.7 Metal Mining MISA Toxicity Review—Chris Wren (ESG International Inc.)	10
3.8 Municipal/Industrial Strategy for Abatement (MISA): Metal Mining Regulations—Yousry Hamdy (Ontario Ministry of the Environment).....	11
3.9 Aquatic Effects Technology Evaluation (AETE) Program: Lessons Learned—Diane Campbell (CANMET)	11
3.10 An Environmental Non-Governmental Organization (ENGO) Perspective—Brennain Lloyd (Northwatch).....	12
3.11 An Environmental Non-Governmental Organization (ENGO) Perspective—Lisa Sumi (Environmental Mining Council of BC).....	12
3.12 An Environmental Non-Governmental Organization (ENGO) Perspective—Judy Parkman (ROAR)	12
3.13 Case Study: Toxicity Control: The Dome Mine Saga (1992–1999)—Ron Connell (Placer Dome)	13
3.14 Case Study: Toxicity Identification/Reduction Evaluation (TI/RE) for Inco Port Colborne—Lesley Novak (ESG International) with David Reed (Inco).....	13
3.15 Case Study: Inco’s Copper Cliff Waste Water Treatment Plant—Glen Watson (Inco).....	14
3.16 Case Study: Battle Mountain Gold’s Holloway Mine—Walter Sencza (Battle Mountain Gold)	14
3.17 Case Study: Falconbridge’s Kidd Creek and Raglan Properties—Bernie Swarbick (Falconbridge).....	15
3.18 The TIME Network—Elizabeth Gardiner (Mining Association of Canada)	15
3.19 Non-Acutely Lethal Mining Effluent Technologies (NALMET)—Patti Orr (Beak International Inc.)	16

3.20 Panel Presentations and Discussions— Bob Michelutti (MAC); Cecilia Fernandez (Canadian Environmental Network); Karen Clark (Canadian Institute for Environmental Law and Policy; Chris Wren (ESG International); Yousry Hamdy (MoE); Patrick Finlay (Environment Canada) 17

4. Projects and Issues Proposed During the TIME Workshop 22

5. Next Steps..... 24

Appendices

A-1. TIME Workshop Agenda

A-2. List of TIME Workshop Participants

A-3. Transparencies/Papers Presented in Plenary Session

- 3.1 *New Metal Mining Effluent Regulations (MMER) and Non-acutely Lethal Effluent (NLE) Requirements*—Patrick Finlay (Environment Canada)
- 3.2 *General Aspects of Toxicology*—Jim McGeer (CANMET, Natural Resources Canada)
- 3.3 *Acute Lethality Reference Methods*—Gary Westlake (Ontario Ministry of the Environment)
- 3.4 *Synopsis of the Report Analysis of National Acute Lethality Database on Canadian Mining Effluent*—Paul Rochon (Environment Canada)
- 3.5 *Overview of Efforts to Address the Mining Effluent Acute Lethality Issue*—Rick Scroggins (Environment Canada)
- 3.6 *An Overview of Mine Effluent Treatment and Estimated Costs*—Mark Anderson (SENES Consultants Ltd.)
- 3.7 *Metal Mining MISA Toxicity Review*—Chris Wren (ESG International Inc.)
- 3.8 *Municipal/Industrial Strategy for Abatement (MISA): Metal Mining Regulations*—Yousry Hamdy (Ontario Ministry of the Environment)
- 3.9 *Aquatic Effects Technology Evaluation (AETE) Program: Lessons Learned*—Diane Campbell (CANMET)
- 3.10 *An Environmental Non-Governmental Organization (ENGO) Perspective*—Brennain Lloyd (Northwatch)
- 3.11 *An Environmental Non-Governmental Organization (ENGO) Perspective*—Lisa Sumi (Environmental Mining Council of BC)
- 3.12 *An Environmental Non-Governmental Organization (ENGO) Perspective*—Judy Parkman (ROAR)
- 3.13 *Case Study: Toxicity Control: The Dome Mine Saga (1992–1999)*—Ron Connell (Placer Dome)
- 3.14 *Case Study: Toxicity Identification/Reduction Evaluation (TI/RE) for Inco Port Colborne*—Lesley Novak (ESG International) with David Reed (Inco)
- 3.15 *Case Study: Inco's Copper Cliff Waste Water Treatment Plant*—Glen Watson (Inco)
- 3.16 *Case Study: Battle Mountain Gold's Holloway Mine*—Walter Sencza (Battle Mountain Gold)
- 3.17 *Case Study: Falconbridge's Kidd Creek and Raglan Properties*—Bernie Swarbick (Falconbridge)

- 3.18 The TIME Network—Elizabeth Gardiner (Mining Association of Canada)
- 3.19 Non–Acutely Lethal Mining Effluent Technologies (NALMET)—Patti Orr (Beak International Inc.)

1. Background and Context

In June of 1999, the Toxicological Investigations of Mining Effluents (TIME) Network was approved in principle by the Mining Association of Canada (MAC) Board of Directors. A meeting was held in Toronto in July among representatives of MAC, the Ontario Mining Association (OMA), MAC member companies, government departments (Environment Canada, Natural Resources Canada, Ministry of Northern Development and Mines), and one consulting firm (ESG International) in which the TIME Network was informally launched. At the meeting, the establishment of a multi-stakeholder advisory or planning group was agreed to, along with a Secretariat at Natural Resources Canada (CANMET), and a date for a multi-stakeholder TIME workshop was determined.

2. Purpose and Structure of the Workshop

The TIME Workshop, held in Ottawa on November 25-26, 1999, had three main purposes:

- to share information among participants on the toxicity of mining effluents;
- to identify challenges, including knowledge gaps, regarding the causes of and solutions to toxicity issues; and
- to identify potential future projects / next steps.

The sixty-two Workshop participants included members of environmental non-governmental organizations, federal and provincial governments, non-governmental organizations, academia, consultants, industry, OMA, and MAC. The list of Workshop participants, and their affiliations, is attached as Appendix 2 of these Proceedings.

These Proceedings represent the output of the TIME Workshop. The Agenda for the Workshop is detailed in Appendix 1. Day One consisted primarily of presentations (15 in total) on various aspects of toxicological issues relating to mining effluents, and included several case studies. The morning of Day Two included 2 presentations and an intensive 2 hour Panel discussion. All of the presentations and the Panel discussions are summarized in Chapter 3 of these Proceedings. Moreover, all of the transparencies used by each of the presenters and the Panel members are duplicated in Appendix 3.

During the early afternoon of Day Two, participants identified a number of TIME issues and projects that require further examination. These issues and projects are listed in Chapter 4. Workshop participants thereafter discussed and agreed upon a process (Next Steps) that would collaboratively pursue the interests of the TIME Network. These next steps are detailed in Chapter 5.

Environment Canada, MAC and Natural Resources Canada provided funding for the TIME Workshop.

Members of the TIME Workshop planning committee included:

Chris Doiron, Environment Canada
Alain Dubreuil, CANMET - Natural Resources Canada
Patrick Finlay, Environment Canada
Elizabeth Gardiner, MAC
Tom Hynes, CANMET - Natural Resources Canada

The project leader for the TIME Workshop was Jennifer Nadeau (CANMET, Natural Resources Canada). Hajo Versteeg was the facilitator and Wylie Thomas was the recorder for the TIME Workshop.

3. Summary of Plenary Presentations

3.1 New Metal Mining Effluent Regulations (MMER) and Non-acutely Lethal Effluent (NLE) Requirements—Patrick Finlay (Environment Canada)

Patrick Finlay welcomed participants to the workshop, noting that the TIME (Toxicological Investigations of Mining Effluents) Network had been launched in July of 1999 at a meeting initiated by the Mining Association of Canada (Elizabeth Gardiner). The purpose of the workshop is to provide an opportunity for stakeholders to share information and experiences (successes and difficulties) on acutely lethal mining effluents and testing. An anticipated outcome is a commitment by the different stakeholder groups to continue with the work of the TIME Network. The secretariat for the Network is currently being provided by CANMET with support from Environment Canada, Natural Resources Canada and the Mining Association of Canada.

Mr. Finlay provided an overview of key events in the modernization of the Metal Mining Liquid Effluent Regulations and Guidelines (MMLER/G, 1977) which led to the development of new Metal Mining Effluent Regulations (MMER). Promulgation of the new regulations is expected for the summer of 2000. The modernization of the regulations involved extensive stakeholder consultations and studies to ensure that they were based on complete and accurate information, and to the greatest extent possible incorporated consensus recommendations from stakeholders. The new regulations will apply to all metal mines (not just “new” mines as in the 1977 MMLER regulations), including gold mines (which were also excluded in the 1977 regulations). They augment the requirements of the old regulations in a number of ways: they add effluent limits for cyanide to the original limits for pH, As, Cu, Pb, Zn, Ni, Ra 226 and total suspended solids (TSS); they lower the limit for TSS from 25 mg/L to 15 mg/L; they require environmental effects monitoring (EEM); and they require non-lethal effluent (NLE) for trout and toxicity testing for *Daphnia magna*. A regulated NLE is consistent with the *Fisheries Act*, which “generally prohibits deposit of deleterious substances into waters frequented by fish”. Reporting requirements under the new regulations have been standardized and streamlined in an effort to provide more timely reporting to stakeholders and the public.

3.2 General Aspects of Toxicology—Jim McGeer (CANMET, Natural Resources Canada)

Jim McGeer gave an overview of acute toxicity associated with mining effluent in freshwater systems: causes, modifying factors and mechanisms of action. He also reviewed briefly how acute toxicity tests are performed and some of the rationale for using *Oncorhynchus mykiss* and *Daphnia magna* as standard test species. They are standardized tests whose pass-fail criteria is 50% mortality in 100% (undiluted) effluent. The causes of toxicity in mining effluents are complex. Mr. McGeer reviewed the sources of toxicity most common to mining effluents, which include certain metal ions, ammonia, high or low pH, thiosalts and suspended solids among others. A number of factors can act to make these more or less toxic. The resulting matrix of potential toxicants, in

combination with other chemical parameters, makes each effluent unique. While information on individual toxicants in an effluent may help, identifying the cause of toxicity can be very difficult.

3.3 Acute Lethality Reference Methods—Gary Westlake (Ontario Ministry of the Environment)

Gary Westlake reviewed the standardized protocols used in conducting acute lethality tests with rainbow trout and *Daphnia magna* in Canada. The reference methods for trout and *Daphnia* contain three procedures: a single concentration; LC50; and, reference toxicants (to test the health of the animals). In Canada, the test procedure for trout is of the static type. This compares to the USEPA procedure, which gives a choice of static, static with replacement and continuous flow. Mr. Westlake explained the reasons for standardizing the test procedures, which include the need to produce comparable and reproducible results, attain national consistency and to facilitate the training of lab staff and clients. Many variables can influence test results and must therefore be carefully controlled in conducting the tests. The standardized tests specify laboratory test conditions, sample handling requirements at the industrial site, in-house laboratory procedures and test reporting requirements (which serves as a check list). Mr. Westlake identified some of the things that can be done to improve the quality of test results, highlighting the important role of accreditation, on-site auditing tools, and data reporting and management.

3.4 Synopsis of the Report Analysis of National Acute Lethality Database on Canadian Mining Effluent—Paul Rochon (Environment Canada)

Paul Rochon presented a synopsis of the findings of the report *Analysis of National Acute Lethality Database on Canadian Mining Effluent* conducted by Steve Andrews. The report and database were developed to address one of the AQUAMIN recommendations that called for a review to determine if the MMLER should be revised to include non-acutely lethal effluent. The project set out to collect data on acute lethality tests (rainbow trout and *D. magna*) at metal mines across Canada in the period 1994–1998, and, where available, link these to effluent chemistry and treatment type. Screening criteria included a requirement that the data be generated by standard test methods only. The resulting database links pass/fail test results, test methods employed, type and status of facility, effluent chemistry and effluent treatment system at 107 mines across the country (89% coverage). Because of differing reporting requirements in the provinces, data for rainbow trout are more complete than for *Daphnia magna*. Mr. Rochon's presentation focused on an analysis of acute lethality results across sectors and regions of the country and over time. An analysis of the data on acute lethality and compliance with MMLER limits indicates that MMLER compliance does not ensure a non-acutely lethal effluent. However, the trend over the last five years has been an improvement in the rainbow trout compliance rate. While not all of the 1998 data are in, the latest status update indicates that only one mine in Canada has periodically lethal effluent (i.e., more than one failure reported per year).

3.5 Overview of Efforts to Address the Mining Effluent Acute Lethality Issue—Rick Scroggins (Environment Canada)

Rick Scroggins summarized activities undertaken to address issues related to acute lethality as a regulated limit in the new Metal Mining Effluent Regulations (MMER). Acute lethality testing of mining effluents is only a recommended monitoring requirement under the existing 1977 federal regulations (MMLER/G), although Quebec, Ontario, British Columbia and Yukon use it as a compliance limit. In 1997, a process was launched to formally amend the MMLER based on the recommendations of a three-year multi-stakeholder review of Aquatic Effects of Mining in Canada (AQUAMIN). Mr. Scroggins reviewed the five principal AQUAMIN recommendations related to acute lethality of mining effluents and how these were addressed. In 1998, a Toxicity Subgroup of the MMLER Amendments Working Group was established to look at options for implementing the five acute lethality recommendations of AQUAMIN, which were incorporated into the last stakeholder version of the new MMER (May 26/99). Importantly, rainbow trout acute lethality is a regulated limit in the May 26th version of the new regulations. Based on the Andrews survey of mine effluent acute lethality (see section 3.4 above), it was concluded that there is insufficient data to require that effluent be non-acutely lethal to *Daphnia magna* at this time. However, the new regulations include a requirement to monitor acute lethality to *D. magna*.

3.6 An Overview of Mine Effluent Treatment and Estimated Costs—Mark Anderson (SENES Consultants Ltd.)

SENES Consultants Ltd. were engaged a year ago to review mine treatment technologies, identify and assess best available technology (BAT) and estimate the additional costs associated with meeting the proposed changes to the regulated parameters under the new MMER—these being a requirement for non-acutely lethal effluent, a limit for cyanide and more stringent limits on total suspended solids. Mark Anderson presented the study's approach, assumptions and conclusions. Ontario mines and some mines in Quebec were excluded from the study of additional costs because current provincial regulatory requirements (e.g., MISA) are at least as stringent as the requirements of the new MMER. Estimating the costs associated with controlling acute lethality requires making assumptions about the cause of lethality. BAT can be applied once the cause of acute lethality has been identified. The SENES study found that most mines in Canada already employ BAT for effluent treatment. The study estimates the additional costs associated with controlling acute lethality (for fifteen properties) to be in the range of \$23.4–\$119 million in capital investment and \$4–15 million/year in operating costs.

3.7 Metal Mining MISA Toxicity Review—Chris Wren (ESG International Inc.)

Chris Wren presented the results of ESG International's study on the performance of 37 Ontario mines in meeting the requirement for non-acutely lethal effluent (*Daphnia magna* and rainbow trout) during the period August 1997–November 1998. The study was

commissioned as a third party review to address some disagreement on figures published under MISA. It also looked at linking observed toxicity with the corresponding chemistry data and summarized findings from Toxicity Identification/Reduction Evaluations (TI/RE) to determine possible causes of toxicity. The study also attempted to determine sources of variability in test results by reviewing test parameters and laboratory and sampling procedures, and found 202 deviations from standard test methodology and 96 deviations related to sample handling and collection. Rainbow trout mortality correlated positively with pH, cyanide, copper and arsenic, while *Daphnia* mortality correlated positively with conductivity, total suspended solids and copper. Results from the TI/REs surveyed point to copper and ammonia as being the most common causes of toxicity. However, results of the study indicate that being within the regulated chemical limits does not guarantee passing the toxicity test.

3.8 Municipal/Industrial Strategy for Abatement (MISA): Metal Mining Regulations—Yousry Hamdy (Ontario Ministry of the Environment)

Yousry Hamdy provided an overview of Ontario's MISA Metal Mining Regulations, which set effluent limits for cyanide, total suspended solids, copper, lead, nickel, zinc, arsenic and pH, and require effluent to pass toxicity tests for *Daphnia magna* and rainbow trout (defined as less than 50 percent mortality in 100 percent effluent). These limits came into force on August 26, 1997. Mr. Hamdy reviewed the scope of application and obligations under the regulations, and examined trends in compliance with non-acutely lethal effluent. The trend is for improved compliance, and Mr. Hamdy stated that today there are only two mines in Ontario that are considered to have problems passing the toxicity tests. Data indicate that since 1990 annual environmental loadings of all the regulated parameters have been reduced by between 53 and 99 percent.

3.9 Aquatic Effects Technology Evaluation (AETE) Program: Lessons Learned—Diane Campbell (CANMET)

Diane Campbell provided an overview of the lessons learned in the implementation of the Aquatic Effects Technology Evaluation (AETE) program, which ran from April 1994 to March 1998. Its mandate was to evaluate cost-effective monitoring technologies for assessing the environmental impacts of mining on the aquatic environment. One of the four questions the program had to address was the organizational level (i.e., from individual to ecosystem) at which monitoring would be both accurate and cost-effective. The technical work of AETE focused on toxicity testing (acute and sub-lethal), biological monitoring and water and sediment monitoring. The program conducted detailed studies at four mine sites across the country to evaluate the effectiveness of the monitoring toolbox it had assembled. One of the shortcomings of this approach was that the methods were tested at highly impacted sites, which may not be representative of the norm. Ms. Campbell identified technical issues that still need to be addressed. She highlighted some of the challenges experienced in implementing the program and shared some of the lessons learned by the players involved (secretariat, stakeholder, and project management). Ms. Campbell felt the program had been a success, and because it ran in parallel with much of the MMLER amendment process, had been able to provide

information required to help move the amendments forward. Key ingredients to the success of the AETE program were transparency, neutrality and openness, among others.

3.10 An Environmental Non–Governmental Organization (ENGO) Perspective—Brennain Lloyd (Northwatch)

Brennain Lloyd presented a perspective from the ENGO community, noting that the environmental community represents a diverse mix of perspectives and experiences from small locally–focused groups to large well–resourced organizations operating at the national or international levels. Delegates from the Canadian Environmental Network (CEN) participating in the TIME workshop are from mid–sized ENGOs working in a collaborative manner to address mining–related environmental concerns. In the broadest sense, ENGOs look at issues of mine effluent through the lens of health—community, human and environment. With regard to mining–related environmental impacts, the ENGO view is to “do no harm”. This perspective is not inconsistent with a number of principles endorsed by the federal government: the precautionary principle; the principle of pollution prevention; sustainable development; zero discharge; and, an ecosystem–based approach. All of these should direct environmental decision–making. Given the above, the ENGO view is that there remains a long distance to go in terms of protecting the environment from the impacts of mining. Ms. Lloyd expressed hope that a future regulatory framework also require that effluent be non-acutely lethal to *Daphnia magna*, as well as address sub–lethal, chronic and cumulative environmental and health effects.

3.11 An Environmental Non–Governmental Organization (ENGO) Perspective—Lisa Sumi (Environmental Mining Council of BC)

Lisa Sumi presented the views of the Mining Caucus of the Canadian Environmental Network (CEN) on the new MMER, identifying three areas of concern. The first relates to the new limits, which, with the exception of total suspended solids (TSS), are the same as the old limits set in 1977. This is in spite of evidence that current technology can achieve much lower limits. Given the high volumes of effluents involved, Ms. Sumi indicated that loadings–based standards would be a more appropriate measure of controlling metals entering the environment. The second area of concern relates to the methodology for determining acute lethality. At a minimum, it should include a test for *Daphnia magna*, which would bring the national standards to those of Quebec and Ontario. Finally, the Mining Caucus is concerned that the new MMER does not provide measures for ensuring that the information collected under the regulation is easily available to the Canadian public.

3.12 An Environmental Non–Governmental Organization (ENGO) Perspective—Judy Parkman (ROAR)

Judy Parkman reviewed briefly issues related to environmental effects monitoring (EEM) from an ENGO perspective. These include: the lack of a clear link between results of

EEM and revisions to the MMLER; the need to achieve a true balance between site specificity and national consistency; and, the lack of a clear commitment to involve the public in EEM. There is a need to establish a national database, linking the results of EEM and evolving BATEA, which would then feed into a process for enhancing the new Metal Mining Effluent Regulations (MMER). Site-specific requirements should be continuously revised to reflect improved technologies and capabilities to mitigate environmental harm to the aquatic receiving environment. National consistency in metal mining can only be achieved by having enough prescription to evaluate monitoring effectiveness, but enough flexibility to accommodate the site-specificity of receiving environments. The public should be involved in all key areas of EEM, yet under current regulations there is no avenue for public involvement. Other more specific "toxicity" challenges are: best approaches to sub-lethal toxicity, resolving confounding and complexing issues, determining acceptable historical toxicity data; and moving beyond simply passing an LC50.

3.13 Case Study: Toxicity Control: The Dome Mine Saga (1992–1999)—Ron Connell (Placer Dome)

Ron Connell reviewed the experience of Dome Mine in Northern Ontario in complying with the requirement under Ontario's MISA regulations that mine effluent be non-lethal to rainbow trout and *Daphnia magna*. The gold mine began addressing toxicity problems of its effluent in 1992, when it became apparent that, in spite of being within the limits for the regulated water chemistry parameters, the mine continued to fail toxicity tests for both test organisms. Initial Toxicity Identification/Reduction Evaluation (TI/RE) studies pointed to ammonia and copper as the probable causes of toxicity to rainbow trout and *Daphnia*, respectively. From 1995 to 1997, the mine constructed and installed treatment plants to remove the identified causes of toxicity, but failed to pass the tests, despite having been successful at the pilot stage. In August 1997, the mine closed down its operations in order to meet the MISA compliance deadline. The mine at this time was well under the limits for water chemistry, but still failed the acute toxicity tests. In 1998, with the help of the Ontario Ministry of the Environment and others, the mine discovered that adding EDTA—a food additive that complexes with copper—to its effluent solved the toxicity problems. Since the spring of 1999, there have been no acute toxicity test failures. The total cost of addressing toxicity at the mine over eight years was \$6.1 million.

3.14 Case Study: Toxicity Identification/Reduction Evaluation (TI/RE) for Inco Port Colborne—Lesley Novak (ESG International) with David Reed (Inco)

David Reed provided background on Inco's Port Colborne facility, which refines precious metals and cobalt and serves as a warehousing centre for Inco's nickel. Untreated effluent from the refinery is toxic to both rainbow trout and *Daphnia*, though more frequently to the latter. Treatment with zeolite was the only effective manipulation to consistently reduce/eliminate toxicity. The refinery engaged ESG International to conduct a Phase I Toxicity Identification/Reduction Evaluation (TI/RE) study to identify the cause of toxicity (i.e., the reason zeolite worked). Lesley Novak presented the results of ESG

International's study. The study examined the effects on mortality of modifying the Na:(Ca+K) ratio of the test solution and measured the chemistry of zeolite- and carbon-treated effluents. The results of the experiments point to the existence of a Na:(Ca+K) threshold in the toxicity response. Regression modelling to predict *Daphnia* mortality identified copper, sodium and carbonates as possible causes of toxicity, but none of these parameters alone explained the toxicity. However, results of ion imbalance experiments and regression analysis do support the hypothesis that toxicity is due to large imbalances between Na and K or between Na and Ca, with K identified as significant in the model. Researchers have not yet been able to confirm the causes of toxicity.

3.15 Case Study: Inco's Copper Cliff Waste Water Treatment Plant—Glen Watson (Inco)

Glen Watson reported on the experience of Inco's Copper Cliff wastewater treatment plant in complying with the non-acutely lethal effluent under MISA. He reviewed the treatment plant and treatment system. Until 1997, the plant was regularly failing toxicity tests for both rainbow trout and *Daphnia magna*. A TIE report concluded that toxicity was probably due to heavy metals and ammonia. They noted a spontaneous change in pH in the effluent whose cause was not determined. In December 1997, they installed an SO₂ treatment plant at a capital cost of \$380 thousand to correct the spontaneous change in pH, which eliminated the toxicity problem.

3.16 Case Study: Battle Mountain Gold's Holloway Mine—Walter Sencza (Battle Mountain Gold)

Walter Sencza reported on the difficulty encountered by Holloway Mine in meeting the requirement for non-lethal effluent under MISA. The gold mine is a stand-alone facility (i.e., no on-site milling), which reached target production in 1996. From the outset, the mine experienced severe difficulty in passing the two toxicity tests, particularly with rainbow trout, despite water quality parameters being well within the proposed regulated limits under MISA. A TI/RE investigation into the cause of toxicity identified non-ionic ammonia as the primary candidate of toxicity with pH being a confounding factor. In the spring of 1997, the mine installed a CO₂ injection system to greatly reduce non-ionic ammonia levels, but continued to experience random failures in the trout acute lethality tests. A review of laboratory raw data revealed that the pH of the test solution climbs to near 8 within the first 24 hours, which causes a ten-fold increase in non-ionic ammonia. Aeration of the test solution, required under the test protocol, appeared to be the cause of the pH rise and subsequent toxicity test failures. Use of pipette bubbling (instead of diffuser stones) for aeration during the toxicity test has helped to reduce the pH rise and associated toxicity test failures. Using static renewal toxicity test procedures (where test solution replacement supplies oxygen instead of aeration), all samples tested to-date have resulted in a pass (in most cases 100% survival of test fish). Results of chronic toxicity seven-day exposure tests and indigenous minnows in the effluent stream also support the non-toxic nature of the effluent at the mine site. Overall, the acute lethality observed using the RM/13 protocol is not indicative of the actual effluent toxicity characteristic of the mine site effluent (primarily due to the artificial pH rise induced during the RM/13 toxicity test when aeration is applied). Further investigations revealed that the

rise in pH -and non-ionic ammonia does not appear to, by itself, explain all of the toxicity test failures. The company conducted additional analyses of the effluent in the hopes of identifying the cause of random failures during winter operations, but to no avail. Although efforts are continuing to identify causes/solutions to the occasional toxicity test failures, the company has opted for zero discharge as the most practicable solution to toxicity. The small quantity of effluent (~500 m³/day) will be transferred to a nearby custom mill for use as process water. The company has also instituted best management practices through ammonia source control and improved water management practices.

3.17 Case Study: Falconbridge's Kidd Creek and Raglan Properties—Bernie Swarbick (Falconbridge)

Bernie Swarbick related the experience at two of Falconbridge's facilities: Kidd Creek Metallurgical Site; and, Raglan Mine. At Kidd Creek, Falconbridge has been addressing toxicity since the late 1980s. Toxicity was determined to be due to a complex relationship between sulphur species (thiosalts, sulphates, etc.), pH depression and dissolved oxygen. Adjusting pH to below 9 using CO₂ resulted in reduced toxicity. While the site has failed *Daphnia* acute toxicity tests on an intermittent basis over the years, it has passed all tests in 1999. Falconbridge's Raglan base metal mine is located in Quebec's Ungava Peninsula about 1800 km north of Montreal. The arctic climate poses several treatment challenges, among them reduced reagent effectiveness due to cold temperatures. The mine uses soda ash in addition to conventional lime treatment and sand filtration. Effluent from the mine was found to be toxic to both *Daphnia* and rainbow trout. The mine has conducted tests to evaluate everything from metals, ammonia, nitrates and pH. Results point to soda ash as a major contributor to toxicity, even though it is not typically toxic at the concentrations observed. How soda ash contributes to toxicity is not known, but it is expected that it is through some complex interaction. The mine is primarily looking at a higher recycle of mill process water in addition to finding a substitute for soda ash in the flotation process.

3.18 The TIME Network—Elizabeth Gardiner (Mining Association of Canada)

Elizabeth Gardiner reviewed the history of TIME (Toxicological Investigations of Mining Effluents), its objectives and relationship to the new Metal Mining Effluent Regulations. Initial funding for the initiative has come from Environment Canada, Natural Resources Canada (CANMET) and the Mining Association of Canada (MAC). In June 1999, the MAC Board of Directors approved in principle the establishment of a national toxicity partnership program. This was followed in July by a meeting at the Ontario Mining Association among representatives from MAC, MAC member companies, government departments (EC, NRCAN and MNDM) and a consulting firm (ESG International), where TIME was informally launched. The meeting established an advisory committee to guide follow-up activities, a secretariat at CANMET and a date for a workshop (November 25–26) to which stakeholders from the network would be invited to share experiences and views and to discuss issues and ways for moving the initiative forward. Ms. Gardiner reviewed some of the benefits that would be derived from proceeding with the TIME initiative and emphasized the importance of ENGO involvement. She reported that the

MAC Board had just recently approved a three-year program to support the initiative at an estimated annual cost of \$175 000, and provided a partial list of priority projects.

3.19 Non-Acutely Lethal Mining Effluent Technologies (NALMET)—Patti Orr (Beak International Inc.)

Patti Orr gave an update on progress with the NALMET project, which is being conducted by Beak International under contract to Environment Canada. The objective of the project is to investigate sources and treatability of constituents in effluent causing ongoing effluent lethality. The project is divided into four broad tasks: background data review; selection of three mines with ongoing lethal effluents for further study; treatability studies; and, preparation of a project report. The project has completed the first two tasks, and is ready to begin investigating the candidate mines. However, few mines are still producing “consistently” lethal effluents, and so only two mines have been identified as meeting the criteria for study. Ms. Orr appealed to the audience for help in identifying a third mine (with toxicity attributable to a toxicant other than ammonia). Next steps for the project are to obtain effluent samples to confirm lethality and tentative causes and begin treatability evaluations.

3.20 Panel Presentations and Discussions— Bob Michelutti (MAC); Cecilia Fernandez (Canadian Environmental Network); Karen Clark (Canadian Institute for Environmental Law and Policy); Chris Wren (ESG International); Yousry Hamdy (MoE); Patrick Finlay (Environment Canada)

Members of the panel provided thoughts and comments on the presentations given over the previous two days. They identified lessons learned, conclusions and issues, and provided suggestions for follow-up action by TIME. Their presentations provided material for a plenary discussion that identified issues and projects that the TIME network/initiative should address. The results of that discussion are captured in Sections 4 and 5 of this report.

Bob Michelutti (Mining Association of Canada)

1. Data

- Work together to get one set of data
- Decide on best statistical way to present data
- Have a good data collection and reporting system (not Mides)

2. Variability of Toxicity Tests

- Improve on toxicity testing
- Should fish continue to be used?
- Need reproducible, cost-effective, fast test

3. BATEA for Toxicity

- Research and develop technologies to ensure that BATEA plant can be available—that is guaranteed to pass toxicity

4. TIE—TRE

- Perform R&D to standardize protocols, reduce costs

5. End of Pipe vs Receiver

- Regulated in receiver
 - perform toxicity: sub-lethal testing
 - loadings: analytical work in pipe to monitor plant/mine
- Should address question “where is the appropriate place to be regulated?”

6. Harmonizations

- One window reporting
- Standardize protocols

- Exempting regulations

Cecilia Fernandez (Clean North/CEN) and Karen Clark (Canadian Institute for Environmental Law and Policy)

1. Lessons Learned

- Regulation drives technology; research was catalyzed by regulation;
- MISA led to 50–90 percent reduction in environmental loadings from mining effluents;
- There are gaps in information, which lead to differing conclusions
- Consistent, reliable recording, monitoring and reporting of data is essential for public participation in discussions—recommend this data be collected within the existing NPRI structure.

Chris Wren (ESG International)

1. Acute Lethality Test Variability

- some variability is to be expected with living organisms and complex effluents
- this is acceptable if results are used for effluent characterization and screening
- there are legal considerations
- can use energy and resources to improve protocol (or leave as is), not discredit it.

2. Solutions to Remove Acute Toxicity

- two examples yesterday of adding more chemicals to eliminate end-of-pipe toxicity
- acute toxicity should be avoided but we need to look at solution in a watershed context
- examine in-stream effects (EEM) along with acute results

3. Role of Consultants

- available technical and scientific expertise
- often the primary group conducting studies and writing reports
- should be objective
- there will be different opinions—that is ok
- encourage sharing of knowledge

4. Information and Technology Transfer

FINAL COPY

- TIME and workshops such as this provide excellent opportunities for exchanging ideas
 - relies on policy of “openness” between and within industry and government
 - case studies were excellent examples
 - within that atmosphere, consultants can also be used more effectively
5. Develop “AETE–II” Program
 - examine more sophisticated technologies
 - collaborate with other industrial sectors with similar issues
 - look to other industries for technologies that can be applied to mining (e.g., agrifood, petrochemical)
 6. Lessons Learned
 - toxicity testing requirements under MISA, EEM will generate wealth of data; let’s use it wisely
 7. Investment in Biological Studies, TIEs/Toxicity Testing
 - studies are not cut and dry
 - results are important and investments should reflect this
 - comparable to engineering work

Yousry Hamdy (Ontario Ministry of the Environment)

1. In Ontario, the patient has recovered. We are just about there.
2. Success stories: Placer Dome, Glimmer mine, Cameco (Port Hope + Blind River)
3. Lessons learned: Industry is demonstrating excellent efforts to meet toxicity requirements. BMP measures such as switching to low ammonia–based explosives; aeration of underground sumps; and EDTA application are but a few examples.
4. Ontario has only two sites that are considered to have challenging problems: Inco’s Port Colborne (outside the new MMER); and Battle Mountain Gold’s Holloway Mine.
5. The remaining challenges are the isolated, non–compliance events.
6. Compliance policy that is reasonable, but progressive.

7. We are concerned and we understand your concerns. A mechanism is needed to identify causes of failure even when they are infrequent (Industry to be proactive)
8. TIME should explore solutions—options e. g., sub-lethal TI/RE
9. Harmonization of MISA/new MMER to eliminate duplication in reporting requirements
10. TIME—any ideas?

Patrick Finlay (Environment Canada)

1. Workshop Impressions

- Industry:
 - committed to achieving Non-lethal effluent
 - multi-disciplinary teams
 - some excellence in consulting
- ENGOS:
 - understand the technical issues
 - provided valuable insights
- Provinces/Territories:
 - Fisheries Act responsibilities
 - Implementation harmony
- Federal Family:
 - working together!
 - (Dept. of Fisheries and Oceans), Natural Resources Canada key support
- Multistakeholder:
 - opportunities
- MMER (*Fisheries Act*):
 - Total Suspended Solids (TSS), pH, metals (technology – national)
 - Non-lethal effluent (biology–national)

- EEM (ecology–site)

2. Performance Standards

- Guidance Documents (EC) :
 - Sampling and analysis
 - Flow and loadings
 - Reporting
 - EEM feedback
 - others
- Code of Practice:
 - Best practice manuals
 - Appropriate references
 - Draft started (Dillon Consultants, Alan Bell)
 - recommended environmental performance standards (auditable)
 - will cite references, e.g., MAC tailings guidelines, Australian Mining Association, US EPA documents
 - Best practice manuals:
 - Ammonia management
 - Toxicity prevention & control
 - TIE/TRE–TTE
 - EEM evaluations/effluent requirements
 - Community liaison (“social license”)
 - Environmental management reporting
 - Emergency plans
 - Mine close–outs (practices and bonds)

4. Projects and Issues Proposed During the TIME Workshop

Following the panel discussions, workshop participants identified a number of issues/projects that could be addressed, as follows (non-prioritized):

1. Need for a consistent, timely, comprehensive, publicly accessible and transparent database on TIME [including a publicly accessible inventory of toxicity problems across Canada];
2. Need to develop a process to provide input to the NALMET study (Non-Acutely Lethal Mining Effluent Techniques)—funded by Environment Canada—on how best to help mines that still have toxicity problems achieve non-acutely lethal effluent (NLE);
3. Assessment of ammonia toxicity, best management practices (BMP) manual and treatment options;
4. Manual for toxicity identification/reduction/treatability evaluation (TI/RE/TTE) for Canadian mine sites;
5. Literature review on best available technology;
6. Evaluation of variability of trout and *Daphnia* tests on effluent samples;
7. Need for protocols for dealing with intermittent toxicity;
8. Relationship between effluent acute lethality, effluent sub-lethal toxicity and receiving water effects; understanding appropriate uses and interpretations of chemical analyses, toxicity tests and receiving water effects;
9. Link between acute and sub-lethal toxicity;
10. Continuous improvement through international BATEA and emerging innovation, supported by a literature review;
11. Development of best environmental practices manuals (BEPM) addressing such areas as:
 - a. toxicity prevention and control;
 - b. EEM results evaluations/effluent requirements;
 - c. community liaison;
 - d. environmental data management and performance reporting;
 - e. (emergency plans);
 - f. (mine close-outs);
 - g. how to assess the quality of effluent data;
12. Review of methodology for predicting and preventing toxicity in new and existing effluents.

Some participants felt that the projects should also address the following:

13. Harmonization between federal and provincial governments of regulations pertaining to mining effluent;
14. Continue developing new tools through an AETE-like program; and
15. Compliance promotion and enforcement policies with respect to the new federal regulations.

Workshop participants agreed that all of the procedural and substantive projects and issues must accommodate the following principles:

- independent science and research ensuring no conflict of interest;
- focus on both trout and *Daphnia magna*;
- openness and transparency;
- common sense; and
- technical expertise.

5. Next Steps

Workshop participants agreed to immediately establish a TIME Network Launch Group. The purpose of the Launch Group is to develop a draft workplan to prioritize and address/implement the issues/projects listed above—“to get things up and running”. Workshop participants agreed that the Launch Group should be comprised of:

- 2 members from the Mining Association of Canada
(including Elizabeth Gardiner)
- 1 member from Environment Canada
(Patrick Finlay)
- 1 member from CANMET
(Alain Dubreuil)
- 1 member from Department of Fisheries and Oceans
- 2 provincial members
(Yousry Hamdy—the secretariat will work with Yousry Hamdy to identify a second member)
- 2 members from Canadian Environment Network
(Sandro di Cori will be the contact person to see whether the CEN Mining Caucus is in a position to name 2 individuals to participate in the Launch Group)
- 1 member from an Aboriginal organization
(the secretariat will contact the Assembly of First Nations and the Inuit Tapirisat to canvass their interest in this matter)

The secretariat function for the Launch Group will be supplied by the current secretariat at CANMET (Jennifer Nadeau).

The Launch Group will develop a draft workplan for the TIME Network, which will include:

- a. mandate/objectives of the TIME Network
 - [- analyse data to determine those mines that can identify causes/sources of effluent toxicity
 - develop an appropriate methodology to identify causes/sources and reduce or eliminate toxicants
 - develop economical treatment technologies to consistently achieve non-acutely lethal effluent.];
- b. membership of the Time Network—at the very least, all of the participants of this workshop will be invited to participate in the TIME Network (see List of Workshop Participants in Appendix A-2);
- c. membership of the TIME Network project planning group who will prioritize projects and provide oversight in their implementation;

FINAL COPY

- d. financing arrangements/contributors for carrying out the various projects (There is an expectation that Environment Canada, Natural Resources Canada and the Mining Association of Canada will sponsor certain projects);
- e. TIME Network secretariat support (likely CANMET)

Once the draft workplan has been completed by the Launch Group, it will be sent for comment to all workshop participants and any other individuals/organizations identified by the Launch Group. Thereafter, it will be finalized (by whom...likely a group identified by the Launch Group that will undoubtedly include many Launch Group members).

Appendix A-1 TIME Workshop Agenda

Toxicological Investigations of Mining Effluents (TIME) Workshop

2-day Workshop:

- Date: November 25th-26th, 1999
- Venue: Embassy West Hotel
1400 Carling Avenue
Ottawa, Ontario K1Z 7L8
Tel: (613) 729-4331
Toll Free: 1-800-267-8696
Fax: (613) 729-1600

Purpose of the Workshop:

- to share information among participants on the toxicity of mining effluents;
- to identify challenges, including knowledge gaps, regarding the causes of and solutions to toxicity issues; and
- to identify potential future projects / next steps.

Participants

- 21 industry
- 16 regulators
- 8 consultants
- 7 ENGOs
- 1 NGO
- 2 academia
- 5 secretariat/CANMET
- 1 facilitator
- 1 recorder

62 total

Topics and Speakers

Thursday, Nov. 25th, 1999:

8:00 - 8:30

Registration and health break

8:30 – 8:45

Welcome and introductory remarks

- Hajo Versteeg, facilitator

8:45 – 9:10

The new *Metal Mining Effluent Regulations* (MMER) and Non-acutely Lethal Effluent (NLE) requirements

- Patrick Finlay (Environment Canada)

9:10 – 9:35

Toxicological Investigations of Mine Effluents – General aspects of toxicology

- Jim McGeer (Natural Resources Canada)

9:35 – 10:00

Acute lethality reference methods (rainbow trout and *Daphnia magna*)

- Gary Westlake (Ontario Ministry of the Environment)

10:00 – 10:15

Health break

10:15 – 10:35

Synthesis of Steve Andrews report, entitled “Analysis of National Acute Lethality Database on Canadian Mining Effluents”

- Paul Rochon (Environment Canada)

10:35 – 11:05

Overview of acute lethality work specific to the Canadian mining sector

- Rick Scroggins (Environment Canada)

11:05 – 11:30

An overview of mine effluent treatment and estimated cost

- Mark Anderson (SENES Consultants Ltd.)

11:30 – 12:00

Discussion of the MISA experience

- Yousry Hamdy (Ontario Ministry of the Environment)
- Chris Wren (ESG International)

12:00 – 13:00

Lunch break

13:00 – 13:20

Lessons learned from the AETE program

- Diane Campbell (Natural Resources Canada)

13:20 – 13:45

Another perspective on the issues

- Brennain Lloyd (Northwatch) with Lisa Sumi (Environmental Mining Council of B.C.) and Judy Parkman (ROAR)

13:45 – 15:00

Case Studies

- Ron Connell, Placer Dome: Toxicity Control: The Dome Mine Saga, 1992-1999
- Lesley Novak with Dave Reed (ESG International / Inco): TI/RE for Inco Port Colborne
- Glen Watson, Inco: Copper Cliff Waste Water Treatment Plant
- Walter Sencza, Battle Mountain: TIME – Holloway Mine
- Bernie Swarbrick, Falconbridge Limited – Kidd Creek and Raglan Properties

15:00 – 15:15

Health break

15:15 – 16:15

Case Studies (continued)

16:15 – 16:30

Closing remarks and adjournment for the day

- Hajo Versteeg, facilitator

17:00 – 19:30

Wine and cheese reception (sponsored by Mining Association of Canada)

Friday, Nov. 26th, 1999:

8:30 – 9:00

Registration and health break

9:00 – 9:10

Welcome and introductory remarks

- Hajo Versteeg, facilitator

9:10 – 9:30

Conclusion of case studies (if necessary)

9:30 – 9:45

What's being done now?

The TIME Network

- Elizabeth Gardiner (Mining Association of Canada)

9:45 – 10:15

What's being done now?

NALMET (Non Acutely Lethal Mining Effluent Techniques) Program

- Patti Orr (BEAK International)

10:15 – 10:30

Health break

10:30 - 12:00

Panel discussion of the material presented on Day 1 and 2

- Panel members:

Karen Clark (Cdn. Institute for Environmental Law & Policy)

Cecilia Fernandez (Clean North)

Patrick Finlay (Environment Canada)

Yousry Hamdy (Ontario Ministry of the Environment)

Bob Michelutti (MAC)

Chris Wren (ESG International)

- Guiding questions:

i. What are the major lessons learned from the foregoing discussions? What are the opportunities for improving the information base?

ii. What are the information gaps and/or challenges regarding

- the causes of, and

- solutions to

toxicity of mining effluents?

iii. Can we apply lessons learned from other programs and initiatives? How do we avoid duplication with other programs and initiatives?

iv. What are the next steps?

12:00 – 13:00

Lunch break

13:00 – 14:00

Prioritization of the issues

14:00 – 15:00

Identification of potential future projects based on the prioritization

15:00 – 15:15

Health break

15:15 – 16:00

Conclusions – path forward

- Hajo Versteeg, facilitator

Appendix A-2 List of TIME Workshop Participants

Gerry Acott, COGEMA Resources Inc.
Gail Amyot, Cambior
Mark Anderson, SENES Consultants Ltd.
Geneviève Béchar, Natural Resources Canada
Bruce Bennet, Jacques Whitford Environment Ltd.
Debbie Berthelot, Mine Waste Management Inc.
Vernon Betts, Homestake Canada Inc.
Sylvie Brassard, Environnement Canada
Diane Campbell, Natural Resources Canada
Ron Campeau, Ontario Ministry of the Environment
Raymond Chabot, Environnement Canada
Peter Chapman, EVS Environment Consultants
Karen Clark, Cdn. Institute for Environmental Law & Policy
Al Colodey, Environment Canada (Pacific & Yukon Region)
Ron Connell, Placer Dome
Catherine Daniel, CEN Mining Caucus
Joe DeGraw, Cameco
Chris Doiron, Environment Canada
Alain Dubreuil, Natural Resources Canada
Simone Dumas, University of Ottawa
Grant Feasby, Lakefield Research
Keith Ferguson, Placer Dome
Cecilia Fernandez, Clean North
Patrick Finlay, Environment Canada
Gordon Ford, B.C. Environment
Wayne Fraser, Hudson Bay Mining & Smelting Co., Ltd.
Ross Gallinger, Rio Algom Ltd.
Elizabeth Gardiner, Mining Association of Canada
André Gauthier, Environnement Canada (Atlantic Region)
Glenn Groskopf, Environment Canada
Yousry Hamdy, Ontario Ministry of the Environment
Kathleen Hedley, Environment Canada
Chris Hilborn, Hatch Management & Technology Consulting
Michael Li, Noranda Technology Centre
Brennain Lloyd, Northwatch
Ron Martel, Barrick Gold
Jim McGeer, Natural Resources Canada
Bob Michelutti, Mining Association of Canada
Barbara Mossop, Ontario Mining Association
Jennifer Nadeau, Natural Resources Canada
Lesley Novak, ESG International
Patti Orr, Beak International
Judy Parkman, ROAR
Roger Payne, Rio Algom Ltd.
Alan Penn, Grand Council of the Crees (Eeyou Istchee)
Francine Perron, Environnement Canada
Kelli Powis, University of Ottawa

Robert Prairie, Noranda Technology Centre
Dave Reed, INCO
Derek Riehm, Teck Corp.
Paul Rochon, Environnement Canada
Dianne Rubinoff, Hatch Management & Technology Consulting
Rick Scroggins, Environment Canada
Walter Sencza, Battle Mountain Gold
Rob Stevens, Dept. of Fisheries and Oceans
Lisa Sumi, Environmental Mining Council of B.C.
Bernie Swarbrick, Falconbridge Limited
Wylie Thomas, recorder
Hajo Versteeg, facilitator
Glen Watson, INCO
Gary Westlake, Ontario Ministry of the Environment
Chris Wren, ESG International
Alan Young, CEN Mining Caucus

TIME Workshop Participants

Name / Address	Telephone #	Fax #
<p>Mr. Gerry Acott</p> <p>Director, Environmental Programs COGEMA Resources Inc. P.O. Box 9204 817 - 825 - 45th Street West Saskatoon, SK S7K 3X5</p>	(306) 343-4586	(306) 343-4640
<p>Ms. Gail Amyot</p> <p>Environmental Engineer Cambior Inc. Pièce 850 800, boul. René Lévesque ouest Montréal (Québec) H3B 1X9</p>	(514) 878-3166	(514) 878-0635
<p>Mr. Mark Anderson</p> <p>Environmental Engineer SENES Consultants Limited 121 Granton Drive, Unit 12 Richmond Hill, ON L4B 3N4</p>	(905) 764-9380	(905) 764-9386
<p>Ms. Geneviève Béchard</p> <p>CANMET, Natural Resources Canada 555 Booth Street, Room 323 Ottawa, ON K1A 0G1</p>	(613) 992-2489	(613) 992-5172
<p>Mr. Bruce Bennett</p> <p>Jacques Whitford Environmental Ltd. 607 Torbay Road St. John's, Newfoundland A1A 4Y6</p>	(709) 576-1458 ext. 222	(709) 576-2126
<p>Ms. Debbie Berthelot</p> <p>Compliance Supervisor Mine Waste Management Inc. 75 Dieppe Avenue Elliot Lake, ON P5A 2R8</p>	(705) 461-1939	(705) 461-1344
<p>Mr. Vernon Betts</p>	(604) 684-2325	(604) 684-9831

Manager, Environmental Affairs
Homestake Canada Inc.
P.O. Box 11115
1055 West Georgia Street, Suite 1100
Vancouver, B.C. V6E 3P3

Mme. Sylvie Brassard (819) 997-0085 (819) 953-5053

Program Officer, Mining Standards
Environment Canada
Minerals & Metals Division
National Office of Pollution Prevention
Place Vincent Massey, 13th floor
351 St. Joseph Blvd.
Hull, QC K1A 0H3

Ms. Diane Campbell (613) 992-1204 (613) 947-6606

CANMET, Natural Resources Canada
555 Booth Street, Room 110
Ottawa, ON K1A 0G1

Mr. Ron Campeau (807) 475-1679 (807) 475-1754

Ontario Ministry of the Environment
435 James Street, South
Suite 331
Thunder Bay, ON P7E 6S7

M. Raymond Chabot (514) 283-0204 (514) 496-6982

Chargé de projets
Protection du milieu aquatique
Environnement Canada
105, rue McGill, 4e étage
Montréal (Québec) H2Y 2E7

Mr. Peter Chapman (604) 986-4331 (604) 662-8548

EVS Environment Consultants
195 Pemberton Avenue
North Vancouver, BC V7P 2R4

Ms. Karen Clark (416) 924-7523 (416) 975-5215

Canadian Institute for Environmental Law
& Policy (CIELAP)
517 College Street, Suite 400
Toronto, ON M6G 4A2

Mr. Al Colodey

(604) 666-2883 (604) 666-9107

Head Industrial Programs
Environment Canada
Pacific and Yukon Region
224 West Esplanade
North Vancouver, BC V7M 3H7

Mr. Ron Connell

(705) 235-6525 (705) 235-6526

Superintendent, Analytical & Envir. Serv.
Placer Dome Canada Limited
P.O. Box 550
Porcupine, ON P0N 1C0

Ms. Catherine Daniel

c/o CEN Mining Caucus

Mr. Joe DeGraw

(705) 358-1496 (705) 358-7772
ext. 3265

Radiation and Environment Officer
Cameco Corporation
P.O. Box 1539
Blind River, ON P0R 1B0

Mr. Christopher Doiron

(819) 953-1105 (819) 953-5053

Senior Specialist, Standards Development
Minerals & Metals Division
National Office of Pollution Prevention
Environment Canada
351 St. Joseph Blvd., 13th floor
Hull, QC K1A 0H3

Mr. Alain Dubreuil

(613) 995-5844 (613) 992-5172

Program Manager, Metals and the

Environment Program
 CANMET, Natural Resources Canada
 555 Booth Street, Room 332A
 Ottawa, ON K1A 0G1

Mme. Simone Dumas

(613) 562-5800 (613) 562-5192
 poste 6646

Sciences de la Terre / Earth Sciences
 Université d'Ottawa
 140, Louis Pasteur
 Ottawa (Ontario) K1N 6N5

Mr. Grant Feasby

(705) 652-2106 (705) 652-0743

Director, Environmental Services
 Lakefield Research Limited
 P.O. Box 4300
 185 Concession Street
 Lakefield, ON K0L 2H0

Mr. Keith Ferguson

(604) 661-1991 (604) 661-3785
 661-1916

Manager, Environmental Affairs
 Placer Dome North America Limited
 P.O. Box 49305, Bentall Postal Station
 600-1055 Dunsmuir St.
 Vancouver, BC V7X 1L3

Ms. Cecilia Fernandez

(705) 942-1427 (705) 945-0595

Clean North
 136 Panoramic Drive
 Sault Ste. Marie, ON P6B 5V6

Mr. Patrick Finlay

(819) 953-1103 (819) 953-5053

Chief, Mining, Minerals & Metals Division
 National Office of Pollution Prevention
 Environment Canada
 351 St-Joseph Blvd., 13th Floor
 Hull, QC K1A 0H3

Mr. Gordon Ford (250) 356-6201 (250) 953-3856

BC Environment
PO Box 9342 Stn Prov Govt
Victoria, BC V8W 9M1

Mr. Wayne Fraser (204) 687-2171 (204) 687-5793

Director, Environment & Plant Engineering
Hudson Bay Mining & Smelting Co., Ltd.
Corner of Church & Fourth Avenue
Flin Flon, MB R3A 2N8

Mr. Ross Gallinger (416) 365-6908 (416) 365-6850

Manager, Environment, Occ. Health &
Safety
Rio Algom Limited
120 Adelaide Street West
Suite 2600
Toronto, ON M5H 1W5

Ms. Elizabeth Gardiner (613) 233-9392 (613) 233-8897
ext. 328

Vice President, Technical Affairs
Mining Association of Canada
Suite 1105
350 Sparks Street
Ottawa, ON K1R 7S8

M. André Gauthier (902) 426-1855 (902) 426-3897

Environmental Engineer
Mining Sector, Pollution Control Section,
Atlantic Region
Environment Canada
16th Floor, Queen Square
45 Alderney Drive
Dartmouth, NS B2Y 2N6

Mr. Glenn Groskopf (306) 780-6078 (306) 780-6466

Mining Project Officer
Environment Canada
Environmental Protection
2365 Albert Street, Room 300
Regina, SK S4S 6X8

Mr. Yousry Hamdy (416) 314-4188 (416) 314-3924

Ontario Ministry of the Environment
Water Policy Branch
135 St. Clair Ave. West
Toronto, ON M4V 1P5

Ms. Kathleen Hedley (819) 953-1553 (819) 953-0461

National EEM Office
Environment Canada
351 St-Joseph Blvd., 8th Floor
Hull, QC K1A 0H3

Mr. Chris Hilborn (905) 403-4072 (905) 403-4046

Project Engineer
Hatch
2800 Speakman Drive
Sheridan Science & Technology Park
Mississauga, ON L5K 2R7

Mr. Michael Li (514) 630-9368 (514) 630-9379

Hydrogeochemical Specialist
Noranda Inc., Technology Centre
240 boul. Hymus
Pointe-Claire, QC H9R 1G5

Ms. Brennain Lloyd (705) 497-0373 (705) 476-7060

Northwatch
P.O. Box 282
North Bay, ON P1B 8H2

Mr. Ron Martel (705) 567-9251 (705) 567-6867
ext. 138

Barrick Gold Corporation
Holt-McDermott Mine
P.O. Box 278
953 Government Road West
Kirkland Lake, ON P2N 3H7

Mr. Jim McGeer (613) 947-3451 (613) 947-5284

Environmental Toxicologist
CANMET, Natural Resources Canada
555 Booth Street, Room 328B
Ottawa, ON K1A 0G1

Mr. Bob Michelutti (705) 858-1167

Ms. Barbara Mossop (416) 364-9301 (416) 364-5986

Manager, Environmental & Engineering
Services
Ontario Mining Association
110 Yonge Street, Suite 1501
Toronto, ON M5C 1T4

Ms. Jennifer Nadeau (613) 992-1762 (613) 992-5172

TIME Secretariat
CANMET, Natural Resources Canada
555 Booth Street, Room 334A
Ottawa, ON K1A 0G1

Ms. Lesley Novak (519) 836-6050 (519) 763-4419

Aquatic Toxicologist
ESG International Inc.
361 Southgate Drive
Guelph, ON N1G 3M5

Ms. Patti Orr (905) 794-2325 (905) 794-2338
ext. 204

BEAK International
14 Abacus Road
Brampton, ON L6T 5B7

Ms. Judy Parkman (604) 534-2303 (604) 533-7854

ROAR
5518-198 Street
Langley, BC V3A 1G2

Mr. Roger Payne (705) 461-2399 (705) 848-6657

General Manager Elliot Lake and East

Kemptville
 Rio Algom Ltd.
 75 Dieppe Ave.
 Elliot Lake, ON P5A 2R8

Mr. Alan Penn (514) 861-5837 (514) 861-0760

Cree Regional Authority
 Suite 100
 277 Duke St.
 Montreal, QC H3C 2M2

Mme. Francine Perron (514) 283-0195 (514) 496-6982

Coordonnatrice de projet, programme
 ESEE
 Protection du milieu aquatique
 Direction de la protection de
 l'environnement
 Environnement Canada
 105, rue McGill, 4e étage
 Montréal (Québec) H2Y 2E7

Ms. Kelli Powis (613) 562-5800 (613) 562-5192
 x.6639

Department of Geology
 University of Ottawa
 Ottawa, ON K1N 6N5

M. Robert Prairie (514) 630-9357 (514) 630-9379

Senior Scientist
 Noranda Technology Centre
 240 Hymus Blvd.
 Pointe Claire, QC H9R 1G5

Mr. Dave Reed (905) 835-7379 (905) 834-9447

Safety Environmental Control Coordinator
 Inco Limited
 Port Colborne Refinery
 Port Colborne, ON L3K 5W2

Mr. Derek Riehm (604) 640-5390 (604) 640-5387

Senior Environmental Engineer

Teck Corporation
 200 Burrard Street
 Suite 600
 Vancouver, BC V6C 3L9

Mr. Paul Rochon (819) 997-2271 (819) 953-5053

Senior Program Engineer, Minerals &
 Metals Division
 National Office of Pollution Prevention
 Environment Canada
 351 St-Joseph Blvd., 13th floor
 Hull, QC K1A 0H3

Ms. Dianne Rubinoff (905) 403-3854

Beddows & Company
 Hatch Management and Technology
 Consulting
 2800 Speakman Drive
 Mississauga, ON L5K 2R7

Mr. Richard Scroggins (613) 990-8569 (613) 990-0173

Manager, Method Development &
 Application Section
 Environmental Technology Centre
 3439 River Road South
 Ottawa, ON K1A 0H3

Mr. Walter Sencza (807) 238-2108 (807) 238-2044

Environment Director
 Battle Mountain Canada Ltd.
 c/o Golden Giant Mine
 P.O. Box 40
 Marathon, ON P0T 2E0

Mr. Rob Stevens (613) 998-9228 (613) 993-7493

Department of Fisheries and Oceans
 Habitat Management Branch
 200 Kent Street, Stn. 12179
 Ottawa, ON K1A 0E6

Ms. Lisa Sumi (250) 384-2686 (250) 384-2620

Research Director
 Environmental Mining Council of BC
 (EMC-BC)
 201-607 Yates St.
 Victoria, BC V8W 2A7

Mr. Bernie Swarbrick (819) 762-7800
 ext. 5121

Superintendent, Environment
 Falconbridge Limited
 Raglan Division

Mr. Wylie Thomas (416) 323-9803 (416) 972-6963

c/o Mr. Hajo Versteeg

Mr. Hajo Versteeg (613) 692-4837 (613) 692-0410

Environmental Law and Policy Advisor
 5365 Hilltop Drive
 Manotick, ON K4M 1G4

Mr. Glen Watson (705) 682-8231

Environmental Biologist
 Inco Limited
 1 Rink Street
 Copper Cliff, ON P0M 1N0

Mr. Gary Westlake (416) 235-5797

Ontario Ministry of the Environment
 125 Resources Road
 Etobicoke, ON M9P 3V6

Mr. Chris Wren (519) 836-6050 (519) 836-2493

ESG International
 361 Southgate Drive
 Guelph, ON N1G 3M5

Mr. Alan Young (250) 384-2686 (250) 480-1375

Chair, Environmental Mining Council of
 British Columbia
 1216 Broad Street
 Victoria, BC V8W 2A5

Appendix A-3
Transparencies/Papers Presented in Plenary Session

3.1 *New Metal Mining Effluent Regulations (MMER) and Non-acutely Lethal Effluent (NLE) Requirements—Patrick Finlay (Environment Canada)*

3.2 General Aspects of Toxicology

—Jim McGeer (CANMET, Natural Resources Canada)

3.3 Acute Lethality Reference Methods
—Gary Westlake (Ontario Ministry of the Environment)

3.4 Synopsis of the Report Analysis of National Acute Lethality Database on Canadian Mining Effluent—Paul Rochon (Environment Canada)

**3.5 Overview of Efforts to Address the Mining Effluent Acute Lethality Issue
—Rick Scroggins (Environment Canada)**

**3.6 An Overview of Mine Effluent Treatment and Estimated Costs
—Mark Anderson (SENES Consultants Ltd.)**

**3.7 Metal Mining MISA Toxicity Review
—Chris Wren (ESG International Inc.)**

3.8 Municipal/Industrial Strategy for Abatement (MISA): Metal Mining Regulations—Yousry Hamdy (Ontario Ministry of the Environment)

**3.9 Aquatic Effects Technology Evaluation (AETE) Program: Lessons Learned
—Diane Campbell (CANMET)**

**3.10 An Environmental Non–Governmental Organization (ENGO) Perspective
—Brennain Lloyd (Northwatch)**

**3.11 An Environmental Non–Governmental Organization (ENGO) Perspective
—Lisa Sumi (Environmental Mining Council of BC)**

**3.12 An Environmental Non-Governmental Organization (ENGO) Perspective
—Judy Parkman (ROAR)**

**3.13 Case Study: Toxicity Control: The Dome Mine Saga (1992–1999)
—Ron Connell (Placer Dome)**

3.14 Case Study: Toxicity Identification/Reduction Evaluation (TI/RE) for Inco Port Colborne—Lesley Novak (ESG International) with David Reed (Inco)

**3.15 Case Study: Inco's Copper Cliff Waste Water Treatment Plant
—Glen Watson (Inco)**

**3.16 Case Study: Battle Mountain Gold's Holloway Mine
—Walter Sencza (Battle Mountain Gold)**

**3.17 Case Study: Falconbridge's Kidd Creek and Raglan Properties
—Bernie Swarbick (Falconbridge)**

3.18 The TIME Network—Elizabeth Gardiner (Mining Association of Canada)

**3.19 Non–Acutely Lethal Mining Effluent Technologies (NALMET)
—Patti Orr (Beak International Inc.)**